

REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention as defined therein. Specifically, claim 27 has been amended to recite that the water-soluble polymer excludes poly(oxyethylene)lauryl ether, polyvinyl alcohol, gelatin and carboxymethylcellulose. Applicants have amended claims 18, 19, 28 and 29 in light of amendments to claim 27.

Moreover, Applicants are adding new claims 33-35 to the application. All of claims 33-35 are independent claims, each reciting a polishing medium for chemical-mechanical polishing. Claims 33-35 recite that the medium includes an oxidizing agent, a protective-film-forming agent, a water-soluble polymer and water. Claim 33 recites that the water-soluble polymer is at least one selected from the group consisting of alginic acid, pectic acid, agar, curdlan and pullulan. Claims 34 and 35 respectively recite that the water-soluble polymer is at least one selected from the group consisting of polycarboxylic acids, polycarboxylic esters, and salts thereof; and that the water-soluble polymer is at least one selected from the group consisting of polyvinyl pyrrolidone and polyacrolein.

In connection with claims 33-35, as well as in connection with amendments to claim 27, note, for example, pages 19 and 20 of Applicants' specification. Note, e.g., Manual of Patent Examining Procedure 2163.05, subsection III, and Union Oil of Cal. v. Atlantic Richfield Co., 54 USPQ 2d 1227, 1232-33 (Fed. Cir. 2000).

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed July 12, 2005, that is, the teachings of United States Published Patent Application

No. US2001/0054706 to Levert, et al., and International (PCT) Published Application No. WO01/11496 (Costas, et al.), under the provisions of 35 USC 102 and 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a polishing medium, or such method of polishing using such polishing medium, as in the present claims, including, inter alia, wherein the polishing medium includes, in addition to an oxidizing agent and water, both a protective-film-forming agent and a water-soluble polymer, such water-soluble polymer excluding poly(oxyethylene)lauryl ether, polyvinyl alcohol, gelatin and carboxymethylcellulose. See claim 27, with respect to the polishing medium; note claim 11, with respect to the method.

Moreover, it is respectfully submitted that the applied references would have neither taught nor would have suggested such a polishing medium for chemical mechanical polishing, as in the present claims, which includes, in addition to an oxidizing agent and water, a protective-film-forming agent and a water-soluble polymer, with the water-soluble polymer being at least one selected from the group consisting of alginic acid, pectic acid, agar, curdlan and pullulan (see claim 33); or wherein the water-soluble polymer is at least one selected from the group consisting of polycarboxylic acids, polycarboxylic esters, and salts thereof (see claim 34); or wherein the water-soluble polymer is at least one selected from the group consisting of polyvinyl pyrrolidone and polyacrolein (see claim 35).

Furthermore, it is respectfully submitted that these applied references would have neither taught nor would have suggested such polishing medium as referred to previously in connection with claim 27, having features as set forth therein, and wherein the medium additionally includes a metal-oxide-dissolving agent. See

claim 1.

Moreover, it is respectfully submitted that the applied references would have neither taught nor would have suggested such polishing medium as in the present claims, having features as discussed previously in connection with claim 27, and, moreover, wherein the water-soluble polymer has a weight-average molecular weight of 500 or more, as in claim 2, more specifically, the weight-average molecular weight as in claims 20 and 21; and/or wherein the water-soluble polymer includes at least two polymers with weight-average molecular weights of at least 500, but whose weight-average molecular weights are different from each other (see claim 3); and/or wherein the polishing medium has a coefficient of kinetic friction of 0.25 or more, as in claims 4 and 13, more particularly, a coefficient of kinetic friction as in claims 22 and 23; and/or wherein the polishing medium has an Ubbelode's viscosity as in claims 5, 14 and 16, more particularly, such viscosity as in claims 24 and 25; and/or wherein the polishing medium has a point-of-inflection pressure as in claims 6, 15 and 17, more particularly, as set forth in claim 26.

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such polishing medium as in the present claims, having features as discussed previously in connection with claim 27 (and/or in connection with claim 1), and having additional features as in the remaining, dependent claims, including (but not limited to) the more specific materials for the oxidizing agent as in claim 7; and/or the more specific materials for the metal-oxide-dissolving agent as in claim 8; and/or the more specific materials for the protective-film-forming agent as in claim 9, more particularly as in claims 10 and 30-32; and/or material of the water-soluble polymer as in claims 18, 19, 28 and 29; and/or wherein the medium is used to polish a film which includes at

least one of copper, a copper alloy, a copper oxide and a copper alloy oxide (see claim 12).

The present invention is directed to a polishing medium for chemical-mechanical polishing (CMP), and a polishing method making use of this medium, especially suited for polishing in forming wirings of semiconductor devices (for example, in polishing copper and copper-containing materials).

In order to obtain a flat polished surface using CMP, of a surface having hills and dales, with a polishing medium including, inter alia, a protective-film-forming agent, it is important to balance the effect attributable to the protective-film-forming agent used in the polishing medium. It is preferable to use a polishing medium which does not etch a metal film surface oxide layer in the dales, yet which has a high rate of polishing of the hills. In particular, it is preferable that the polishing rate is high, yet wherein the etching rate of the polishing medium is low.

Applicants provide a polishing medium which can form highly reliable buried metal film patterns in a good efficiency keeping a high CMP rate (that is, having a high polishing rate), and wherein the etching rate by the polishing medium is low. Applicants have found that by incorporating a specified water-soluble polymer in a polishing medium containing, inter alia, an oxidizing agent, a protective-film-forming agent and water, the CMP rate can be made higher, while the etching rate is kept low. See page 7, lines 12-21 of Applicants' specification. Note also the paragraph bridging pages 21 and 22, and page 23, lines 5-20, of Applicants' specification.

Thus, where a polishing medium for CMP which contains 1% by weight of benzotriazole (a protective-film-forming agent) is used, the film is usually polished only a little even when solid abrasive grains are contained in the polishing medium. Moreover, where only a water-soluble polymer is mixed in the polishing medium for

CMP and no protective-film-forming agent is included, it is difficult to control etching rate to be low. Through use of the combination of the protective-film-forming agent and the water-soluble polymer, as in the present invention, achievement of both a high CMP rate and a low etching rate is accomplished; and, moreover, through use of this combination of the protective-film-forming agent with the water-soluble polymer, it is not necessary to include solid abrasive grains in the medium.

In addition, as described on pages 8-12 of Applicants' specification, Applicants have found various characteristics of the water-soluble polymer and of the polishing medium as a whole, which enable achievement of much higher CMP rate, higher flattening, lower dishing level and lower erosion level. These characteristics are specific ranges for the weight-average molecular weight of the water-soluble polymer, the coefficient of kinetic friction of the polishing medium, the Ubbelode's viscosity of the polishing medium and the point-of-inflection pressure of the polishing medium. Note especially, page 8, line 23 to page 9, line 2; the paragraph bridging pages 9 and 10; page 11, lines 16-18; and the paragraph bridging pages 11 and 12, of Applicants' specification.

Attention is directed to the Examples and Comparative Examples; and, in particular, the results thereof, as seen in Tables 1-3 on pages 29 and 30 of Applicants' specification. It is respectfully submitted that the Examples and Comparative Examples in these tables constitute evidence in connection with showing unexpectedly better results achieved by the presently claimed subject matter, and must be considered when determining patentability. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984).

Thus, in comparing the Examples with Comparative Examples 1-4, unexpectedly better results can be seen in decreased etching rate with improved

CMP (chemical-mechanical polishing) rate. Further unexpectedly better results are seen with molecular weight of the water-soluble polymer, point-of-inflection pressure, Ubbelode's viscosity and coefficient of kinetic friction, as in various of the present claims. See page 30, line 3 to page 32, line 12, of Applicants' specification.

Levert, et al. discloses a chemical etching process for the planarization of surfaces, and chemical compositions especially suited thereto, the technique described therein being a spin etch planarization. Note paragraphs [0002], [0019] and [0021] on pages 1 and 2 of Levert, et al. This patent publication contrasts the spin etch planarization to chemical mechanical polishing, as being different techniques, disclosing that chemical-mechanical polishing has several disadvantages which the spin etch planarization described in this patent publication intends to reduce or eliminate. See paragraph [0016] on page 2 of Levert, et al. As for the specific spin etch planarization described in this patent publication, which is disclosed as being particularly suitable for copper and tantalum, note paragraph [0022] bridging pages 2 and 3 of this patent publication. Note also Tables 1-10 in paragraphs [0059]-[0068] on pages 5 and 6 of this patent document, describing various reagent solutions and reagents for planarization of copper and of tantalum.

Initially, it is emphasized that Levert, et al. is directed to spin etch planarization of surfaces, contrasting this technique with chemical mechanical polishing. See, e.g., paragraphs [0008]-[0012] and [0016] on pages 1 and 2 of Levert, et al. In contrast, according to the present invention, etching rate is kept low, while a high chemical mechanical polishing rate is achieved. It is respectfully submitted that Levert, et al., disclosing a spin etch planarization composition, would have taught away from the present invention, which is a polishing medium for chemical-mechanical polishing; and, more specifically, would have taught away from

the polishing method in, e.g., claim 11, which includes polishing a polishing object film with the polishing medium for chemical-mechanical polishing according to claim 27.

In addition, it is respectfully submitted that Levert, et al. would have taught away from a composition as in, for example, present claims 27 and 33-35, wherein the medium excludes poly(oxyethylene)lauryl ether, polyvinyl alcohol, gelatin and carboxymethylcellulose as the water-soluble polymer; or wherein the water-soluble polymer is selected from the specific polymers as in claims 33-35.

In this regard, and emphasizing that Levert, et al. discloses an etching composition, it is respectfully submitted that the water-soluble polymer as in the present claims is different from, and performs a different function than, the materials disclosed in Levert, et al.; and it is respectfully submitted that Levert, et al. would have neither taught nor would have suggested such medium as in the present claims, including the recited water-soluble polymer and advantages achieved thereby.

In particular, it is respectfully submitted that Levert, et al. neither discloses, nor would have suggested, the various specific materials as in claims 33-35, as the water-soluble polymer of the polishing medium recited in these claims.

In the paragraph bridging pages 2 and 3 of the Office Action mailed July 12, 2005, the Examiner accurately sets forth that Levert, et al. teaches an etching solution, for spin etch planarization. Particularly in view thereof, it is respectfully submitted that Levert, et al. would have neither taught nor would have suggested the polishing medium or method as in the present claims, and the various components of the medium as in the present claims, or functioning of these components or advantages of the present medium and method.

It is respectfully submitted that the additional teachings of Costas, et al. would not have rectified the deficiencies of Levert, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Costas, et al. discloses polishing and planarization of integrated circuit surfaces, including a composition that can be used in chemical mechanical polishing slurries to prevent scratching, minimize surface roughness, and eliminate coating of gelled slurries or residue on the IC wafer surface. The composition includes an organic polymer having a backbone comprised of at least 16 carbon atoms, the polymer having a plurality of moieties with affinity to surface groups on the semiconductor wafer surface. According to other aspects as disclosed in Costas, et al., the composition includes a surfactant having a carbon chain backbone comprised of at least 16 carbon atoms; or the composition is an aqueous composition having a pH of under 5.0 and includes polyacrylic acid having a specified number average molecular weight, or blends of high and low number average molecular weight polyacrylic acids. Note, for example, page 2, line 16 through page 3, line 10 of Costas, et al. This patent document discloses that the compositions described therein may further comprise at least one of submicron abrasive particles, a dispersing agent, an oxidizing agent and a complexing agent. See page 3, lines 26-28. Note also page 4, lines 3-7; page 4, line 29 through page 5, line 1; and page 6, lines 1-16, of Costas, et al. Note also page 8, lines 7-9 of Costas, et al.

Initially, it is emphasized that Costas, et al. is directed to chemical mechanical polishing compositions; while Levert, et al. is directed to spin etch planarization compositions, which Levert, et al. expressly discloses are different from chemical mechanical polishing compositions. Particularly in view thereof, it is respectfully

submitted that one of ordinary skill in the art concerned with in Levert, et al., would not have looked to the teachings of Costas, et al. In other words, it is respectfully submitted that Levert, et al. and Costas, et al. constitute non-analogous art.

In addition, and emphasizing that Levert, et al. is concerned with spin etch planarization compositions, that is, etching compositions, while Costas, et al. is directed to compositions for chemical mechanical polishing, it is respectfully submitted that there would have been no motivation for combining the teachings of Levert, et al. and Costas, et al., as applied by the Examiner.

In any event, it is respectfully submitted that the combined teachings of Levert, et al. and of Costas, et al. would have neither taught nor would have suggested the presently claimed subject matter, including, inter alia, combination of specified water-soluble polymer, especially as in claims 33-35, and protective-film-forming agent, and advantages thereof; and/or other features of the present invention as discussed previously, and advantages thereof.

The contention by the Examiner that Levert, et al. "teaches the same composition mixture" as claimed by Applicants is noted. As indicated previously, the present claims exclude various polymers described in Levert, et al., and it is respectfully submitted that the present claims are such that Levert, et al. does not teach, nor would have suggested, the composition mixture of the present claims.

The contention by the Examiner in the paragraph bridging pages 6 and 7 of the Office Action mailed July 12, 2005, that using the composition of Levert, et al. "in the same manner as in the claimed invention would inherently result in the same polishing medium as claimed by [Applicants]" is not understood. With respect to the presently claimed method, Applicants recite a polishing medium and method; Levert, et al. discloses an etching composition and method, which Levert, et al. discloses

specifically is different from chemical mechanical polishing. It is respectfully submitted that Levert, et al. would have taught away from the presently claimed process.

Emphasizing that the present claims recite a polishing medium, for chemical-mechanical polishing, it is respectfully submitted that Levert, et al. would have taught away from the medium as in the present claims.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case No. 1204.41259X00), and please credit any excess fees to such account.

Respectfully submitted,

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